Has China's Interregional Capital Mobility Been Low? A Spatial Econometric Estimation of the Feldstein-Horioka Equation

Yoshihiro Hashiguchi and Kuang-hui Chen

Kobe University

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Yoshihiro HASHIGUCHI† CHEN Kuang-hui‡

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Abstract

We conducted a Feldstein-Horioka test for the degree of China's inter-provincial capital mobility each year from 1978 to 2007 using the spatial error model (SEM), a model of spatial econometrics considering spatial dependence, and a data set reflecting revision of historical national and provincial accounts after China's first economic census in 2004. We found that the likelihood ratio test rejected the null of no spatial error correlation, or the appropriateness of the standard OLS model (OLSM), for 17 out of 30 years and that the Akaike information criterion selected the SEM over the OLSM for 20 years. Our estimations demonstrate that the mobility was high until the late 80's, fell to a bottom in the mid-90's, recovered, peaked in the early 2000's, and has weakened recently, even though it has been argued that mobility has been low since 1978 reform, leaving the impression that it has consistently been low.

Keywords: fiscal and financial reform, Feldstein-Horioka paradox, spatial econometrics
JEL: C21, O16, P21

1 Introduction

A distinctive phenomenon has emerged in post-1978 reform China. Oi [15] has called it "local state corporatism," and Jin, Qian, and Weingast [8] have called it "federalism, Chinese style." The "fiscal contracting system" introduced in 1980 provided strong

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†Graduate School of Economics, Kobe University, Nada, Kobe 657-8501, Japan. Email: yhashiguchi@port.kobe-u.ac.jp.

‡Graduate School of International Cooperation Studies, Kobe University, Nada, Kobe 657-8501, Japan. Email: chen@person.kobe-u.ac.jp.

fiscal incentives for local governments to boost their economies. While such decentralization achieved some success in economic development, arguments have been put forward that it decreased the central government's redistribution function and worsened regional inequality [9, 10] and that local governments tended to interfere in the capital market and cause its fragmentation [4, 16]. Often regarded as evidence supporting these claims, previous estimates using the Feldstein-Horioka equation [5] have shown that post-1978 China's capital mobility among regions was low. The mobility seems to have been regarded as consistently low despite a sequence of fiscal and financial reforms, such as implementation of the "tax assignment system," enforcement of the Law of the People's Bank of China and of the Commercial Bank Law, in the mid-1990's and large "western development plan" investments in this decade [3, 4, 12, 18].

Our argument is threefold. First, most previous studies presumed that mobility was stable for a considerable period. Their estimates may have been flawed by this constant parameter presumption, and, in fact, Hashiguchi and Hamori's year-by-year estimation showed that mobility began to increase in the mid-1990's [6]. Second, China conducted its first economic census in 1994 and has substantially revised its historical national account estimates [14, 19]. Previous estimates may also change if revised data are used. Third, although several versions of the Feldstein-Horioka equation have been estimated for various countries and regions using various methods [2], spatial dependence in cross-regional and panel data has not been considered, possibly affecting properties of estimators [1].

Using revised cross-provincial data and a method of spatial econometrics, we made a year-by-year estimation from 1978 to 2007 and showed that capital mobility has not been consistently low. We describe our model in the next section, report estimation results in Section 3, and conclude in Section 4.

2 Model

The basic Feldstein-Horioka equation is of the form:

$$\frac{I_i}{Y_i} = \alpha + \beta \frac{S_i}{Y_i} + u_i, \tag{1}$$

where Y_i is country/region i's GDP, I_i is gross investment, S_i is saving, and u_i is an error. Now well-known as the Feldstein-Horioka paradox, Feldstein and Horioka [5] found β, the saving-retention coefficient, was significantly larger than zero and was rather close to one in 21 OECD countries, indicating a tendency that incremental savings were invested domestically even though capital mobility was thought to be large among developed countries.

We estimate Equation (1) by taking account of spatial dependence in the error term. Using matrix notation and rewriting Equation (1) as

$$\mathbf{y} = \mathbf{X}\boldsymbol{\beta} + \mathbf{u}, \tag{2}$$

we assume that the error $\mathbf{u}$ follows the spatial autoregressive process:

$$\mathbf{u} = \lambda \mathbf{W} \mathbf{u} + \boldsymbol{\varepsilon}, \tag{3}$$

where $\mathbf{W}$ is a row-standardized spatial weight matrix such that the ith element of the vector $\mathbf{W}\,\mathbf{u}$ is the mean error of region i's neighbors, λ is a coefficient of autocorrelation, and $\boldsymbol{\varepsilon}$ is a vector of iid errors.[1]

The above model is called the spatial error model (SEM), which is reduced to the ordinary least square model (OLSM) if $\lambda = 0$. It can be estimated by the maximum likelihood method. Assuming the error $\boldsymbol{\varepsilon}$ to be normally distributed with a zero mean vector and a covariance matrix of $\sigma^2\mathbf{I}$, we have from Equations (2) and (3) a log-likelihood function of

$$\begin{aligned}\log L(\boldsymbol{\beta}, \lambda, \sigma^2) = &- \frac{N}{2}\log 2\pi - \frac{N}{2}\log\sigma^2 - \frac{1}{2}\log|\boldsymbol{\Omega}_\lambda| \\ &- \frac{1}{2\sigma^2}(\mathbf{y} - \mathbf{X}\boldsymbol{\beta})'\boldsymbol{\Omega}_\lambda{}^{-1}(\mathbf{y} - \mathbf{X}\boldsymbol{\beta}),\end{aligned} \tag{4}$$

where

$$\boldsymbol{\Omega}_\lambda = [(\mathbf{I} - \lambda\,\mathbf{W})'(\mathbf{I} - \lambda\,\mathbf{W})]^{-1},$$

$\mathbf{I}$ is an identity matrix, and N is sample size. The usual first-order condition yields the maximum likelihood estimators of $\boldsymbol{\beta}$ and σ^2 given λ:

$$\begin{aligned}\hat{\boldsymbol{\beta}}_\lambda &= (\mathbf{X}'\boldsymbol{\Omega}_\lambda{}^{-1}\mathbf{X})^{-1}\mathbf{X}'\boldsymbol{\Omega}_\lambda{}^{-1}\mathbf{y}, \\ \hat{\sigma}^2_\lambda &= \frac{1}{N}(\mathbf{y} - \mathbf{X}\hat{\boldsymbol{\beta}}_\lambda)'\boldsymbol{\Omega}_\lambda{}^{-1}(\mathbf{y} - \mathbf{X}\hat{\boldsymbol{\beta}}_\lambda),\end{aligned} \tag{5}$$

substitution of which into Equation (4) yields the following concentrated log-likelihood function:

$$\log L(\lambda) = -\frac{N}{2}\left[\log(2\pi) + 1\right] - \frac{N}{2}\log\left(\frac{\mathbf{u}_\lambda{}'\mathbf{u}_\lambda}{N}\right) + \log|\mathbf{I} - \lambda\,\mathbf{W}|, \tag{6}$$

where

$$\begin{aligned}\mathbf{u}_\lambda &= \left[\mathbf{I} - \mathbf{X}_\lambda(\mathbf{X}_\lambda{}'\mathbf{X}_\lambda)^{-1}\mathbf{X}_\lambda{}'\right]\mathbf{y}_\lambda, \\ \mathbf{X}_\lambda &= (\mathbf{I} - \lambda\,\mathbf{W})\,\mathbf{X}, \\ \mathbf{y}_\lambda &= (\mathbf{I} - \lambda\,\mathbf{W})\,\mathbf{y}.\end{aligned}$$

The maximum likelihood estimate of λ is the value that maximizes Equation (6), and its substitution into Equation (5) gives the estimates of $\boldsymbol{\beta}$ and σ^2.

For estimation we use a weight matrix $\mathbf{W}$ of the queen contiguity type, which treats two regions as neighbors if they share a border or a point, and the data on gross regional expenditure, on final consumption, and on fixed capital formation of 29 province-level regions, excluding Hainan and Chongqing.[2] The OLS model is also estimated for comparison. R version 2.10.1 [17] is used for calculation.

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[1] The $\mathbf{u}$ can be considered to be a random individual effect [11, Ch. 2].

[2] Hainan and Chongqing are excluded because of lack of data. Data are obtained from the National Bureau of Statistics [13] with the following modifications: Inner Mongolian 2005 expenditure is from the Inner Mongolia Autonomous Region Bureau of Statistics [7]; Zhejiang fixed capital formations until 2004 are judged to be misprinted under the entry net export [13, p. 433].

3 Estimation Results

Parameter estimates of the SEM and OLSM per year from 1978 to 2007 are given in Tables 2 and 3.

Table 1: Model Selection Statistics

	LR	AIC	
		SEM	OLSM
1978	4.086**	-40.9*	-38.8
1979	2.765*	-32.3*	-31.5
1980	5.325**	-63.1*	-59.8
1981	4.954**	-75.9*	-72.9
1982	4.380**	-63.5*	-61.1
1983	7.120***	-72.1*	-67.0
1984	4.439**	-75.8*	-73.4
1985	4.686**	-60.8*	-58.1
1986	2.639	-65.4*	-64.7
1987	1.734	-60.5	-60.8*
1988	5.914**	-76.8*	-72.9
1989	5.786**	-78.6*	-74.8
1990	2.824*	-73.4*	-72.6
1991	2.137	-69.7*	-69.6
1992	0.958	-60.7	-61.7*
1993	0.011	-60.6	-62.6*
1994	0.046	-51.8	-53.7*
1995	0.035	-57.1	-59.1*
1996	1.473	-60.1	-60.6*
1997	3.783*	-64.9*	-63.1
1998	3.746*	-64.0*	-62.2
1999	1.960	-65.5	-65.5*
2000	3.277*	-61.4*	-60.1
2001	4.966**	-57.3*	-54.3
2002	5.994**	-55.5*	-51.5
2003	3.343*	-43.4*	-42.0
2004	1.863	-52.6	-52.7*
2005	1.162	-51.1	-51.9*
2006	1.748	-54.4	-54.6*
2007	2.525	-50.2*	-49.7

Note: *, **, and *** next to LR values denote that the null of $\lambda = 0$ is rejected at the 10%, 5%, and 1% significance level, respectively. * in the columns of AIC are given to smaller values.

Table 1 compares the two models. The likelihood ratio (LR) test rejects the null of the spatial autoregressive parameter $\lambda = 0$, or the appropriateness of the OLSM, at the 10% significance level for 17 out of 30 years and at the 5% level for 10 years. The Akaike information criterion (AIC) selects the SEM for 20 years. The LR and AIC are consistent. The AIC selects the SEM whenever the LR rejects $\lambda = 0$.

Figure 1 shows the SEM and OLSM confidence intervals (solid lines) and point estimates (dashed line) of the saving-retention coefficient β. The two estimates are similar, providing support to Hashiguchi and Hamori [6]. The coefficient, according to them, was low until the late 1980's, rose to the peak in the mid-90's, declined thereafter, and bottomed in the early 2000's. Estimates for the early 2000's are significantly less than zero, indicating a tendency that investments were large in regions where savings were small, a tendency which now seems to have disappeared.

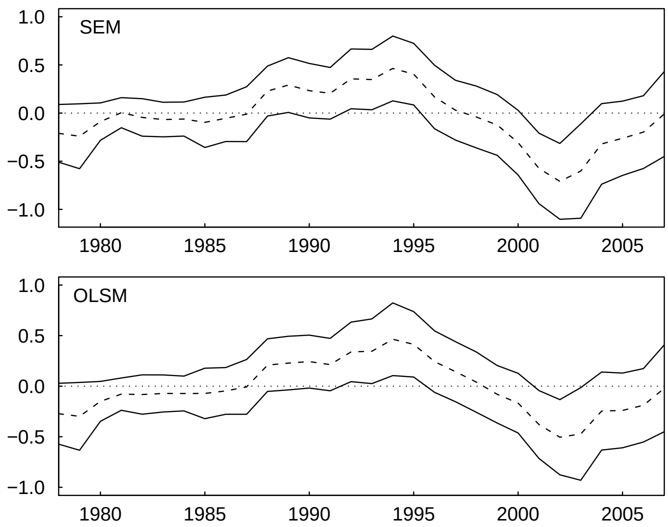

Figure 1: Confidence Intervals and Point Estimates of the Retention Coefficient

4 Conclusion

It has been argued that following 1978 reform China's decentralization decreased the redistribution function of the central government, tended to cause local governments' interference in the capital market, and, as a result, depressed interregional capital mobility, which has seemingly been regarded as consistently low. According to our estimate of the saving-retention rate, however, mobility was high until the late 1980's, fell to a bottom in the mid-90's, recovered, peaked in the early 2000's, and has weakened recently. It appears that mobility, depressed by "excessive decentralization," was raised by fiscal and financial reforms in the mid-90's and "western development plan" investments in the 2000's, although we have no evidence that whether problems identified have been solved. Indeed, mobility is estimated to have weakened recently.

References

[1] Luc Anselin and Anil K. Bera. Spatial dependence in linear regression models with an introduction to spatial econometrics. In Aman Ullah and David E. A. Giles, editors, *Handbook of Applied Economic Statistics*, pages 237–89. Marcel Dekker, New York, 1998.

[2] Nicholas Apergis and Chris Tsoumas. A survey of the Feldstein-Horioka puzzle: What has been done and where we stand. *Res. Econ.*, 63(2):64–76, 2009.

[3] Genevieve Boyreau-Debray. Financial intermediation and growth: Chinese style. Working Paper 3027, World Bank, 2003.

[4] Genevieve Boyreau-Debray and Shang-Jin Wei. Pitfalls of a state-dominated financial system: the case of China. Working Paper 11214, NBER, 2005.

[5] Martin Feldstein and Charles Horioka. Domestic saving and international capital flows. *Econ. J.*, 90(358):314–29, 1980.

[6] Yoshihiro Hashiguchi and Shigeyuki Hamori. Saving-investment relationship and capital mobility: Evidence from Chinese provincial data, 1980-2007. *Econ. Bull.*, 29(3):1981–89, 2009.

[7] Inner Mongolia Autonomous Region Bureau of Statistics. *Inner Mongolia Statistical Yearbook 2009*. China Statistics P, Beijing, 2009.

[8] Hehui Jin, Yingyi Qian, and Barry R. Weingast. Regional decentralization and fiscal incentives: Federalism, Chinese style. *J. Public Econ.*, 89(9-10):1719–42, 2005.

[9] Ravi Kanbur and Xiaobo Zhang. Fifty years of regional inequality in China: A journey through central planning, reform, and openness. *Rev. Dev. Econ.*, 9(1):87–106, 2005.

[10] John Knight and Li Shi. Fiscal decentralization: Incentives, redistrubution and reform in China. *Oxf. Dev. Stud.*, 7(1):5–32, 1999.

[11] James LeSage and R. Kelley Pace. *Introduction to Spatial Econometrics*. CRC, Boca Raton, FL, 2009.

[12] Cheng Li. Savings, investment, and capital mobility within China. *China Econ. Rev.*, 21(1):14–23, 2010.

[13] National Bureau of Statistics Department of Comprehensive Statistics. *China Compendium of Statistics 1949-2008*. China Statistics P, Beijing, 2010.

[14] National Bureau of Statistics Department of National Accounts. *Data of Gross Domestic Product of China (1952-2004)*. China Statistics P, Beijing, 2007.

[15] Jean C. Oi. Fiscal reform and the economic foundations of local state corporatism in China. *World Politics*, 45(1):99–126, 1992.

[16] Albert Park and Kaja Sehrt. Tests of financial intermediation and banking reform in China. *J. Comp. Econ.*, 29(4):608–44, 2001.

[17] R Development Core Team. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, 2009.

[18] Shinichi Watanabe. The inter-provincial capital flows in China before and after the transition to a market economy. In Mariko Watanabe, editor, *Recovering Financial Systems: China and Asian Transition Economies*, pages 69–79. Palgrave, New York, 2006.

[19] Xianchun Xu. The establishment, reform, and development of China's system of national account. *Rev. Income and Wealth*, 55(S1):442–65, 2009.

Table 2: SEM Estimates

	$\hat{\alpha}$		$\hat{\beta}$		$\hat{\lambda}$	
1978	0.338^{***}	(0.065)	-0.210	(0.153)	0.461^{**}	(0.190)
1979	0.347^{***}	(0.070)	-0.241	(0.172)	0.382^{*}	(0.205)
1980	0.275^{***}	(0.044)	-0.089	(0.099)	0.551^{***}	(0.171)
1981	0.219^{***}	(0.034)	0.004	(0.080)	0.528^{***}	(0.176)
1982	0.272^{***}	(0.041)	-0.045	(0.099)	0.477^{**}	(0.187)
1983	0.287^{***}	(0.041)	-0.067	(0.092)	0.585^{***}	(0.163)
1984	0.304^{***}	(0.038)	-0.062	(0.090)	0.500^{***}	(0.182)
1985	0.357^{***}	(0.056)	-0.096	(0.133)	0.509^{***}	(0.181)
1986	0.341^{***}	(0.048)	-0.054	(0.123)	0.413^{**}	(0.200)
1987	0.327^{***}	(0.056)	-0.011	(0.145)	0.329	(0.214)
1988	0.226^{***}	(0.055)	0.229^{*}	(0.132)	0.566^{***}	(0.168)
1989	0.161^{***}	(0.058)	0.291^{**}	(0.145)	0.563^{***}	(0.168)
1990	0.183^{***}	(0.056)	0.233	(0.144)	0.422^{**}	(0.198)
1991	0.212^{***}	(0.054)	0.205	(0.137)	0.361^{*}	(0.209)
1992	0.180^{***}	(0.066)	0.355^{**}	(0.158)	0.268	(0.223)
1993	0.217^{***}	(0.069)	0.348^{**}	(0.160)	0.031	(0.249)
1994	0.169^{**}	(0.074)	0.463^{***}	(0.172)	-0.064	(0.255)
1995	0.182^{***}	(0.070)	0.404^{**}	(0.163)	0.058	(0.247)
1996	0.288^{***}	(0.072)	0.167	(0.168)	0.350^{*}	(0.211)
1997	0.348^{***}	(0.071)	0.030	(0.158)	0.495^{***}	(0.184)
1998	0.400^{***}	(0.074)	-0.041	(0.164)	0.478^{**}	(0.187)
1999	0.430^{***}	(0.070)	-0.123	(0.161)	0.350^{*}	(0.211)
2000	0.515^{***}	(0.075)	-0.307^{*}	(0.171)	0.472^{**}	(0.188)
2001	0.640^{***}	(0.083)	-0.575^{***}	(0.187)	0.547^{***}	(0.172)
2002	0.713^{***}	(0.090)	-0.709^{***}	(0.201)	0.583^{***}	(0.164)
2003	0.704^{***}	(0.113)	-0.602^{**}	(0.250)	0.447^{**}	(0.193)
2004	0.597^{***}	(0.100)	-0.320	(0.213)	0.327	(0.214)
2005	0.593^{***}	(0.094)	-0.262	(0.197)	0.239	(0.227)
2006	0.581^{***}	(0.094)	-0.198	(0.193)	0.268	(0.223)
2007	0.506^{***}	(0.111)	-0.009	(0.225)	0.302	(0.218)

Note: Standard errors in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% significance level, respectively.

Table 3: OLSM Estimates

	$\hat{\alpha}$		$\hat{\beta}$	
1978	0.362***	(0.059)	-0.272*	(0.154)
1979	0.367***	(0.065)	-0.298*	(0.171)
1980	0.293***	(0.036)	-0.150	(0.101)
1981	0.243***	(0.028)	-0.079	(0.081)
1982	0.278***	(0.034)	-0.083	(0.099)
1983	0.282***	(0.033)	-0.072	(0.093)
1984	0.302***	(0.032)	-0.072	(0.088)
1985	0.336***	(0.047)	-0.072	(0.127)
1986	0.328***	(0.042)	-0.047	(0.118)
1987	0.316***	(0.051)	-0.007	(0.138)
1988	0.219***	(0.050)	0.208	(0.133)
1989	0.170***	(0.050)	0.228*	(0.135)
1990	0.169***	(0.049)	0.243*	(0.134)
1991	0.201***	(0.050)	0.213	(0.132)
1992	0.182***	(0.061)	0.339**	(0.150)
1993	0.218***	(0.070)	0.345**	(0.163)
1994	0.170**	(0.079)	0.464**	(0.183)
1995	0.177**	(0.071)	0.414**	(0.165)
1996	0.247***	(0.065)	0.243	(0.155)
1997	0.286***	(0.065)	0.143	(0.151)
1998	0.351***	(0.067)	0.040	(0.152)
1999	0.405***	(0.063)	-0.080	(0.145)
2000	0.446***	(0.065)	-0.168	(0.151)
2001	0.545***	(0.073)	-0.379**	(0.171)
2002	0.615***	(0.081)	-0.505***	(0.190)
2003	0.644***	(0.104)	-0.472**	(0.234)
2004	0.562***	(0.092)	-0.246	(0.197)
2005	0.583***	(0.090)	-0.240	(0.189)
2006	0.577***	(0.090)	-0.189	(0.185)
2007	0.511***	(0.108)	-0.021	(0.219)

Note: Standard errors in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% significance level, respectively.